

REMARKS

By this amendment, claims 1 and 2 have been cancelled and claims 3 and 4 have been added. Thus, claims 3 and 4 are now active in the application. Reexamination and reconsideration of the application are respectfully requested.

The specification and abstract have been carefully reviewed and revised to make grammatical and idiomatic improvements in order to aid the Examiner in further consideration of the application. The amendments to the specification and abstract are incorporated in the attached substitute specification and abstract. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and Abstract by the current amendment. The attachment is captioned "Version with markings to show changes made."

The substitute specification includes revisions to the discussions of the labyrinths 13 and 50 is shown in Figs. 2-4, and the structures forming gaps G1 – G3 and gaps G4 – G6 constituting the labyrinths. The revisions to the specification provide reference numerals to better identify the various structures, including the gaps, as now claimed in claims 3 and 4. The newly-added reference numerals in the specification are also shown in the replacement drawing sheets of Figs. 3 and 4. Specifically, in the replacement drawing sheets, Fig. 3 has been amended to provide reference numerals for the disk portion 10a of the washer 10, as well as the gaps G1, G2 and G3. Fig. 4 has been amended to provide reference numerals for the head 47a of the bolt 47, as well as the recess R, the disk portion 46b of the washer 46 and the gaps G4 – G6. It is noted that the reference numerals R, 46b and G4 – G6 are provided for the structures shown on the right side of the coupling piece 37 in Fig. 4, but the same reference numerals apply to the corresponding structures on the left side in Fig. 4. Replacement Fig. 4 also includes the addition of reference numeral 40a to properly reference the central bore 40a of the bushing 40, as referenced in paragraph [0032] of the specification.

At the middle of page 2 of the Office Action, claim 1 was rejected under 35 U.S.C. 112, second paragraph, because the phrase "the engine pulley" lacked proper antecedent basis. This rejection is believed moot in view of the cancellation of claim 1. Furthermore, the new claims 3 and 4 have been carefully drafted to avoid this particular problem, and to otherwise clearly comport with the requirements of 35 U.S.C. 112, second paragraph.

Next, claim 1 [and claim 2*] was rejected under 35 U.S.C. 103(a) as being unpatentable over Katogi (U.S. 6,036,612) in view of Bellamy (U.S. 6,458,055). This rejection is believed moot in view of the cancellation of claims 1 and 2. Furthermore, this rejection is believed clearly inapplicable to new claims 3 and 4, for the following reasons.

**Although claim 2 was not included in the statement of the rejection at the bottom of page 2 of the Office Action, it is noted that claim 2 was referenced in the body of the rejection at, for example, line 1 of page 5 of the Office Action.*

With exemplary reference to the drawing figures (and especially to Figs. 1-3), new independent claim 3 sets forth a tension adjusting device for an engine accessory driving belt B, comprising: a tension pulley 1 configured to be brought into contact with the engine accessory driving belt B; a pivotable pulley arm 2 supporting the tension pulley 1 and having a boss 3 at one end thereof, the boss 3 having an end surface (right end surface in Figs. 2 and 3) and being formed with a shaft insertion hole 4 which opens through the end surface of the boss 3; a slide bearing 5 pressed in the shaft insertion hole 4 and having at one end thereof a flange 5a in abutment with the end surface of the boss 3; a tubular fulcrum shaft 6 mounted in the slide bearing 5; a bolt 7 axially extending through the fulcrum shaft 6 and configured to be brought into threaded engagement with an engine block 8, thereby pivotally supporting the pulley arm 2; a hydraulic auto-tensioner 20 for applying a regulating force to the pulley arm 2, thereby pressing the tension pulley 1 against the belt B; a washer 10 comprising a disk portion 10a and a cylindrical portion 11 axially extending from a radially outer edge of the disk portion 10a, the disk portion 10a being disposed between a head 7a of the bolt 7 and the end surface of the boss 3 so as to axially face the flange 5a of the slide bearing 5 with a first gap G1 between the flange 5a of the slide bearing 5 and the disk portion 10a of the washer 10, the cylindrical portion 11 of the washer 10 surrounding an end portion of the boss 3 including the end surface of the boss 3; and a slinger 12 comprising a cylindrical portion 12a having first and second axial ends, the first axial end (right end in Fig. 3) being disposed closer than the second axial end (left end in Fig. 3) to the end surface of the boss 2, and a flange 12b radially outwardly extending from the second axial end of the cylindrical portion 12a of the slinger 12, the cylindrical portion 12a of the slinger 12 being mounted on the end portion of the boss 3 and radially facing the cylindrical portion 11 of the washer 10 with a second gap G2 between

the cylindrical portion 12a of the slinger 12 and the cylindrical portion 11 of the washer 10, the flange 12b of the slinger 12 axially facing an axial end surface (leftwardly-facing axial end surface in Fig. 3) of the cylindrical portion 11 of the washer 10 with a third gap G3 between the flange 12b of the slinger 12 and the end surface (leftwardly-facing axial end surface in Fig. 3) of the cylindrical portion 11 of the washer 10, the first, second and third gaps G1 – G3 communicating with each other so as to define a labyrinth 13.

Thus, claim 3 has been drafted so as to now specifically claim distinguishing structural features of the labyrinth 13 and, in particular, that the labyrinth 13 is constituted by the gaps G1, G2 and G3 (see replacement Fig. 3 submitted herewith). The locations of these gaps G1, G2 and G3 are specifically claimed by reciting the surfaces between which they are defined. That is, the first gap G1 is defined between the flange 5a of the slide bearing 5 and the disk portion 10a of the washer 10. The second gap G2 is defined between the cylindrical portion 12a of the slinger 12 and the cylindrical portion 11 of the washer 10. The third gap G3 is defined between flange 12b of the slinger 12 and the axial end surface (leftwardly-facing end surface in Fig. 3) of the cylindrical portion 11 of the washer 10.

In contrast, neither of the Katogi and Bellamy patents teaches or suggests the now specifically-defined structure of the tubular slide bearing 5, the washer 10 and the slinger 12 which define the gaps G1, G2 and G3 forming the labyrinth 13. The labyrinth 13 constituted by the gaps G1 – G3 is purposefully made as a complicated shape and configured to effectively prevent the entry of foreign matter. The Examiner specifically relied upon the Bellamy patent for teaching the presence of a washer 30, bolt 28, boss 44 and slinger (not numbered but shown by arrows on page 4 of the Office Action). Clearly, however, the Bellamy structure is not configured in the specific complicated manner to prevent the entry of foreign matter, as set forth in new independent claim 3.

Further, there is no suggestion that would have caused a person having ordinary skill in the art to modify the Katogi arrangement either taken individually or in combination with Bellamy, in such a manner as to result in or otherwise render obvious the present invention as now specifically defined in the independent claim 3. Therefore, it is respectfully submitted that claim 3 is clearly allowable over the prior art of record.

Next, again with exemplary reference to the drawing figures and, in particular, Figs. 1 and 4, new independent claim 4 sets forth a tension adjusting device for an engine accessory driving belt B, comprising: a tension pulley 1 configured to be brought into contact with the engine accessory driving belt B; a pivotable pulley arm 2 supporting the tension pulley 1; a hydraulic auto-tensioner 20 for applying a regulating force to the pulley arm 2, thereby pressing the tension pulley 1 against the belt B, the auto-tensioner 20 having at one end thereof a coupling piece 37 formed with a bushing insertion through hole 43 extending between two sides thereof; a tubular bushing 45 inserted in the bushing insertion through hole 43; a bolt 47 inserted through the bushing 45 and brought into threaded engagement with the pulley arm 2 and tightened to fix the bushing 45 to the pulley arm 2, thereby pivotally coupling the one end of the hydraulic auto-tensioner 20 to the pulley arm 2; and first and second washers 46, the first washer (e.g., left-side washer in Fig. 4) comprising a disk portion 46b disposed between opposed surfaces of the bushing 45 and the pulley arm 2, and a cylindrical portion 46a axially extending from a radially outer edge of the disk portion 46b of the first washer 46 toward the second washer (e.g., right-side washer in Fig. 4) such that the cylindrical portion 46a of the first washer has a distal end with an axially-facing end surface (e.g., rightwardly-facing end surface in Fig. 4), the second washer (e.g., right-side washer in Fig. 4) comprising a disk portion 46b disposed between opposed surfaces of the bushing 45 and a head 47a of the bolt 47, and a cylindrical portion 46a axially extending from a radially outer edge of the disk portion 46b of the second washer toward the first washer (e.g., left-side washer in Fig. 4) such that the cylindrical portion 46a of the second washer has a distal end with an axially-facing end surface (e.g., leftwardly-facing end surface in Fig. 4); wherein the coupling piece has first and second annular protrusions 49 each formed at one of two open ends of the bushing insertion through hole 43; wherein the first annular protrusion (e.g., left-hand side annular protrusion 49 in Fig. 4) has an axial end surface (e.g., leftwardly-facing end surface in Fig. 4) axially facing the disk portion 46b of the first washer (e.g., left washer in Fig. 4) with a first gap G4 between the disk portion 46b of the first washer 46 and the axial end surface of the first annular protrusion 49, and a radially outer surface radially facing the cylindrical portion 46a of the first washer 46 with a second gap G5 between the cylindrical portion 46a of the first washer 46 and the radially outer surface of the first annular protrusion 49, the first

annular protrusion 49 defining a first recess (e.g., left-hand side recess R in Fig. 4) radially outside thereof which has an axially-facing bottom that axially faces the axially-facing end surface at the distal end of the cylindrical portion 46a of the first washer 46 with a third gap G6 between the axially-facing bottom of the first recess R and the axially-facing end surface at the distal end of the cylindrical portion 46a of the first washer 46, the first, second and third gaps G4 – G6 communicating with each other so as to define a first labyrinth 50; wherein the second annular protrusion (e.g., right-side protrusion 49 in Fig. 4) has an axial end surface axially facing the disk portion 46b of the second washer (e.g., right-side washer in Fig. 4) with a fourth gap G4 between the disk portion 46b of the second washer 46 and the axial end surface of the first annular protrusion 49, and a radially outer surface radially facing the cylindrical portion 46a of the second washer (e.g., right-side washer 46 in Fig. 4) with a fifth gap G5 between the cylindrical portion 46b of the second washer 46 and the radially outer surface of the second annular protrusion 49, the second annular protrusion 49 defining a second recess (e.g., right-side recess R in Fig. 4) radially outside thereof which has an axially-facing bottom that axially faces the axially-facing end surface of the distal end of the cylindrical portion 46a of the washer 46 with a sixth gap G6 between the axially-facing bottom of the second recess R and the axially-facing end surface at the distal end of the cylindrical portion 46a of the second washer 46, the fourth, fifth and sixth gaps (e.g., gaps G4 – G6 on the right-side of Fig. 4) communicating with each other so as to define a second labyrinth 50.

Thus, similarly to claim 3 discussed above, claim 4 now specifically recites the complex configurations of the labyrinths 50 on the left-side and right-side, respectively of the coupling piece 37 shown in Fig. 4. In particular, claim 4 recites the specific configuration of the labyrinth 50, formed on the left side in Fig. 4, as formed by the first annular protrusion 49 (left-side protrusion 49), the recess R defined radially outside of the protrusion 49, and the first washer 46 (left-side washer 46). The second labyrinth structure 50, as shown on the right side in Fig. 4, is also specifically recited as constituting the gap G6 shown on the right side in Fig. 4 as formed by the right-side protrusion 49, the right-side recess R and the right-side washer 46. These now specifically-recited structures of the labyrinths 50 and of the structure forming the labyrinths are not disclosed or suggested in either of the Katogi et al. or Bellamy references whether taken individually or in

combination. As discussed above with respect to claim 3, the Examiner relied upon the Bellamy patent for disclosing structure creating a labyrinth, but the structure in Bellamy clearly does not meet the limitations now present in claim 4 either with respect to the structure of the annular protrusions 49, recesses R, and washers 46 or with respect to the gaps G4 – G6 forming the labyrinths 50.

As such, it is believed apparent that a person having ordinary skill in the art would not have found it obvious to modify the Katogi et al. configuration whether taken individually or in combination with the Bellamy patent, in such a manner as to result in or otherwise render obvious the present invention of claim 4. Therefore, it is respectfully submitted that claim 4 is also clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice thereof is earnestly solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, it is respectfully requested that the Examiner contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

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SPECIFICATION

TENSION ADJUSTING DEVICE FOR ENGINE ACCESSORY DRIVING BELT

TECHNICAL FIELD

[0001]

This invention relates to a tension adjusting device for a belt for driving engine accessories such as an alternator and a water pump.

BACKGROUND ART

[0002]

~~Patent document 1~~ Japanese patent publication 10-299846A

discloses a conventional tension adjusting device for an engine accessory driving belt. Like the belt tension adjusting device according to the present invention, which is shown in Fig. 1, this conventional tension adjusting device includes a pulley arm 2 pivotally mounted on an engine block, a tension pulley 1 rotatably mounted on the pulley arm 2 so as to be in contact with the slack side of the belt B, and a hydraulic auto-tensioner 20 for applying a regulating force to the pulley arm 2, thereby pressing the tension pulley 1 against the belt B. The hydraulic auto-tensioner 20 includes a built-in hydraulic damper for damping a pressing force applied to the pulley arm 2 from the belt B through the tension pulley 1.

[0003]

In the conventional arrangement, as shown in Fig. 5, the pulley arm 2 has a boss 3 at its end in which a shaft inserting hole 60 is formed to extend along the central axis of the boss 3. A pair of tubular slide bearings

61 each having a flange 61a at one end thereof are pressed into the shaft ~~inserting-insertion~~ hole 60. A fulcrum shaft 62 is further inserted in the slide bearings 61. The fulcrum shaft 62 has a small-diameter threaded shaft portion ~~63~~ at its front end which is threaded into a threaded hole 65 formed in the engine block 64 and tightened to support the pulley arm 2.

[0004]

Seal grooves 66 are formed at both ends of the fulcrum shaft 62. O-rings 67 are fitted in the respective seal grooves 66 and each elastically in contact with the inner periphery of one of the pair of slide bearings 61 to prevent entry of muddy water and dust into between the contact surfaces of the slide bearings 61 and the fulcrum shaft 62.

[0005]

Also, in the conventional arrangement, as shown in Fig. 6, the hydraulic auto-tensioner 20 has a coupling piece 68 formed with a ~~bush~~ ~~inserting-bushing insertion~~ hole 69 extending therethrough from one to the other side thereof. A tubular slide bearing 70 is pressed into the ~~bush~~ ~~inserting-bushing insertion~~ hole 69. A ~~bush-bushing~~ 71 is inserted in the slide bearing 70. A bolt 73 is inserted through the ~~bush-bushing~~ 71 and a pair of washers 72 each in abutment with one of the end surfaces of the ~~bush-bushing~~ 71, and is threaded into a threaded hole 74 formed in the pulley arm 2 and tightened. The pulley arm 2 is thus coupled to the hydraulic auto-tensioner 20.

[0006]

A pair of seal grooves 75 are formed in the outer periphery of the ~~bush-bushing~~ 71 each near one end thereof. O-rings 76 are each received in one of the seal grooves 75 and elastically in contact with the inner periphery of the slide bearing 70 to prevent entry of muddy water and dust

into between the contact surfaces of the slide bearing 70 and the bush
bushing 71.

~~_Patent document 1: Japanese patent publication 10-299846A~~

~~DISCLOSURE OF THE INVENTION~~

~~PROBLEMS TO WHICH THE INVENTION SEEKS SOLUTION~~

[0007]

In the supporting structure of the pulley arm 2 of the above-described conventional belt tension adjusting device, and the coupling structure for coupling the pulley arm 2 to the hydraulic auto-tensioner 20, when the belt B vibrates at high speed while the engine is running, the pulley arm 2 pivots about the fulcrum shaft 62 at high speed, and the pulley arm 2 and the hydraulic auto-tensioner 20 also pivot relative to each other about their coupling portions at high speed. Thus, by contact with the slide bearings 61 and 70, the O-rings 67 and 76 tend to become worn and suffer deterioration in sealability, thereby making long use of the entire device difficult.

[0008]

Also, in order to mount the O-rings 67 and 76, the seal grooves 66 and 75 have to be formed. In order to optimally control the interference of the O-rings 67 and 76, such seal grooves 66 and 75 have to be finished with precision, so that the manufacturing cost tends to be high.

~~SUMMARY OF THE INVENTION~~

[0009]

A first object of the present invention is to provide a tension adjusting device for an engine accessory driving belt which can maintain

high sealability in the bearing portion pivotally supporting the pulley arm for a long period of time, and which can be manufactured at a low cost.

[0010]

A second object of the present invention is to provide a tension adjusting device for an engine accessory driving belt which can maintain high sealability in the coupling portion for coupling the pulley arm to the hydraulic auto-tensioner for a long period of time, and which can be manufactured at a low cost.

~~MEANS TO ACHIEVE THE OBJECTS~~

[0011]

In order to achieve the first object, according to a first aspect of the invention, there is provided a tension adjusting device for an engine accessory driving belt comprising a tension pulley configured to be brought into contact with the engine accessory driving belt, a pivotable pulley arm supporting the tension pulley and having a boss at one end thereof, the boss being formed with a shaft ~~inserting-insertion~~ hole, a tubular fulcrum shaft mounted in the shaft ~~inserting-insertion~~ hole, a bolt axially extending through the fulcrum shaft and configured to be brought into threaded engagement with an engine block and tightened to fix the fulcrum shaft to the engine pulley, thereby pivotally supporting the pulley arm, and a hydraulic auto-tensioner for applying a regulating force to the pulley arm, thereby pressing the tension pulley against the belt, characterized in that a washer is disposed between a head of the bolt and an end surface of the boss, the washer having a cylindrical portion covering an end portion of the boss including the end surface, and that a slinger is mounted on the end portion of the boss, the cylindrical portion of the washer and the slinger defining a

labyrinth therebetween.

[0012]

In order to achieve the second object, according to a second aspect of the invention, there is provided a tension adjusting device for an engine accessory driving belt comprising a tension pulley configured to be brought into contact with the engine accessory driving belt, a pivotable pulley arm supporting the tension pulley, a hydraulic auto-tensioner for applying a regulating force to the pulley arm, thereby pressing the tension pulley against the belt, the auto-tensioner having at one end thereof a coupling piece formed with a ~~bush-inserting-bushing insertion~~ through hole extending between two sides thereof, a tubular ~~bush-bushing~~ inserted in the ~~bush-inserting-bushing insertion~~ through hole, and a bolt inserted through the ~~bush-bushing~~ and brought into threaded engagement with the pulley arm and tightened to fix the ~~bush-bushing~~ to the pulley arm, thereby pivotally coupling the one end of the hydraulic auto-tensioner to the pulley arm, characterized in that two washers are disposed between opposed surfaces of the ~~bush-bushing~~ and the pulley arm and between opposed surfaces of the ~~bush-bushing~~ and a head of the bolt, respectively, each of the washers having an outer cylindrical portion extending toward the coupling piece, and that the coupling piece has two annular protrusions each formed at one of two open ends of the ~~bush-inserting-bushing insertion~~ through hole, the cylindrical portion of each of the washers and the corresponding one of the annular protrusions defining a labyrinth therebetween.

....

~~ADVANTAGES OF THE INVENTION~~

[0013]

In the tension adjusting device for an engine accessory driving belt

according to the first aspect of the invention, the labyrinth prevents the entry of muddy water and dust into the bearing portion about which the pulley arm pivots. Because the labyrinth is a non-contact seal, it maintains its sealing function for a long period of time. Since this seal is simple in structure, the entire device can be manufactured at a low cost.

[0014]

In the tension adjusting device for an engine accessory driving belt according to the second aspect of the invention, the labyrinth prevents the entry of muddy water and dust into the coupling portion through which the pulley arm and the hydraulic auto-tensioner are pivotally coupled together. Because the labyrinth is a non-contact seal, it maintains its sealing function for a long period of time as in the first aspect of the invention. Also, since this seal is simple in structure, the entire device can be manufactured at a low cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a front view of a tension adjusting device for an engine accessory driving belt embodying the present invention;

Fig. 2 is a sectional view taken along line II-II of Fig. 1;

Fig. 3 is a partial enlarged sectional view of Fig. 2;

Fig. 4 is a sectional view taken along line IV-IV of Fig. 1;

Fig. 5 is a sectional view of a conventional support structure for a pulley arm; and

Fig. 6 is a sectional view of a conventional coupling structure for coupling a pulley arm to a hydraulic auto-tensioner.

~~DESCRIPTION OF REFERENCE NUMERALS~~

~~{0016}~~

~~B—belt~~

~~1—tension pulley~~

~~2—pulley arm~~

~~3—boss~~

~~4—shaft inserting hole~~

~~6—fulcrum shaft~~

~~7—belt~~

~~7a—head~~

~~10—washer~~

~~11—cylindrical portion~~

~~12—slinger~~

~~13—labyrinth~~

~~20—hydraulic auto-tensioner~~

~~37—coupling piece~~

~~43—bush inserting hole~~

~~45—bush~~

~~46—washer~~

~~46a—cylindrical portion~~

~~47—belt~~

~~47a—head~~

~~49—annular protrusion~~

~~50—labyrinth~~

~~BEST MODE FOR EMBODYING DETAILED DESCRIPTION OF THE~~
~~INVENTION~~

[0017]

Now the embodiments of the present invention are described with reference to Figs. 1 to 4. As mentioned above, Fig. 1 shows the tension adjusting device for a belt for driving engine accessories according to the present invention. Figs. 2 and 3 show a bearing portion for pivotally supporting ~~the a~~ pulley arm 2. As shown in Figs. 2 and 3, the pulley arm 2 is provided with a boss 3 protruding from both sides thereof. The boss 3 is formed with a shaft receiving hole 4 comprising a stepped hole. A shoulder 4a is formed on the inner periphery of the shaft receiving hole 4 at one end thereof.

[0018]

A pair of tubular slide bearings 5 are pressed into the shaft receiving hole 4. Each slide bearing 5 has a flange 5a at one end thereof. The flange 5a of one slide bearing 5 abuts the shoulder 4a of the shaft receiving hole 4, and the flange 5a of the other slide bearing 5 abuts the other end of the boss 3.

[0019]

A tubular fulcrum shaft 6 is inserted in the pair of slide bearings 5. The fulcrum shaft 6 is fixed to an engine block 8 by tightening a bolt 7 inserted through a central hole 6a thereof. The fulcrum shaft 6 is fixed to the engine block 8 with washers 9 and 10 in abutment with both ends thereof so that the pulley arm 2 is pivotable about the fulcrum shaft 6.

[0020]

The washer 10 is disposed between ~~the a~~ head 7a of the bolt 7 and ~~the an~~ end surface of the fulcrum shaft 6. The washer 10 has a disk portion 10a axially facing flange 5a across a gap G1, and an outer cylindrical portion 11 covering the other end of the boss 3. A slinger 12 is mounted on

the outer periphery of the boss 3 at the other end thereof. The slinger 12 comprises a cylindrical portion 12a pressed onto the other end of the boss 3 and radially facing the outer cylindrical portion 11 of the washer 10 across a gap G2, and a flange 12b formed at one end of the cylindrical portion 12a and axially facing an axially-facing end surface of the outer cylindrical portion 11 of the washer 10 across a gap G3. A labyrinth 13 is formed between the slinger 12 and the cylindrical portion 11 of the washer 10 by the gaps G1, G2, and G3 that, as shown, are in communication with each other.

[0021]

By mounting the slinger 12 having the flange 12b on the other end of the boss 3 to form the labyrinth 13 between the slinger 12 and the ~~cylindrical portion 11 of the washer 10~~, it is possible to prevent entry of muddy water and dust into the contact portion between the fulcrum shaft 6 and the slide bearings 5. The flange 12b of the slinger 12 prevents the entry of any muddy water that may flow along the surface of the pulley arm 2 and drip onto the bearing portion into the labyrinth 13.

[0022]

Because the labyrinth 13 is a non-contact seal, it maintains its sealing function and prevents entry of muddy water and dust for a long period of time even if the pulley arm 2 pivots about the fulcrum shaft 6 at a high speed. Since the sealing structure is simple, the entire device can be manufactured at a low cost.

[0023]

Fig. 4 shows a hydraulic auto-tensioner 20 for applying a regulating force to the pulley arm 2. The auto-tensioner 20 comprises a cylinder 21 made of an aluminum alloy and filled with hydraulic oil, an oil seal 22

sealing the top opening of the cylinder 21 with air trapped in the cylinder 21 on the hydraulic oil, a rod 23 slidably extending through the oil seal 22, a return spring 24 biasing the rod 23 outwardly of the cylinder 21, and a hydraulic damper 25 for dampening the pressing force applied to the rod 23.

[0024]

The return spring 24 is provided around the cylinder 21 with one end thereof supported by a flange 26 provided on the outer periphery of the cylinder at the bottom end thereof and the other end pressed against a spring washer 27 mounted to the top end of the rod, thereby biasing the rod 23 outwardly of the cylinder 21.

[0025]

The hydraulic damper 25 includes a plunger 29 slidably mounted in a sleeve 28 having a closed bottom to define a pressure chamber 30 and a reservoir chamber 31 in the cylinder 21. The plunger 29 is formed with a passage 32 through which the pressure chamber 30 communicates with the reservoir chamber 31. The hydraulic damper 25 further includes a check valve 33 for opening and closing the passage 32, and a plunger spring 34 mounted in the pressure chamber 30 and pressing the plunger 29 against the bottom of the rod 23.

[0026]

The check valve 33 closes the passage 32 when the pressure in pressure chamber 30 exceeds the pressure in the reservoir chamber 31.

[0027]

The auto-tensioner further includes a wear ring 35 supporting a mid-portion of the rod 23 and movable up and down together with the rod 23, while being guided along the inner wall of the cylinder 21.

[0028]

As shown in Fig. 4, a coupling piece 36 provided at the bottom end of the cylinder 21 is pivotally supported by the engine block 8, and a coupling piece 37 provided on the spring washer 27 at the top end of the rod 23 is coupled to the pulley arm 2, thereby mounting the hydraulic auto-tensioner 20 in position.

[0029]

With the auto-tensioner 20 thus mounted, when the belt B slackens, the return spring 24 pushes the rod 23 out of the cylinder 21, thus pivoting the pulley arm 2 to press the tension pulley 1 against the belt B. The belt B is thus re-tensioned.

[0030]

When the tension of the belt B increases, a pressing force is applied to the rod 23 through the tension pulley 1 and the pulley arm 2. The pressing force is dampened by the hydraulic damper 25.

[0031]

When the pressing force exceeds the spring force of the return spring 24, the pressure in the pressure chamber 30 exceeds the pressure in the reservoir chamber 31, so that the passage 32 is closed by the check valve 33. Thereafter, hydraulic oil in the pressure chamber 30 gradually leaks through a small gap between the sliding surfaces of the plunger 29 and the closed-bottomed sleeve 28 into the reservoir chamber 31, allowing the rod 23 to retract until the force of the return spring 24 balances with the pressing force. The tension of the belt B is thus kept constant.

[0032]

The coupling piece 36 provided at the bottom end of the cylinder 21 is formed with a through hole 38 extending between both sides thereof. A tubular slide bearing 39 is pressed in the through hole 38. A ~~bush~~ bushing

40 is inserted in the slide bearing 39. A bolt 42 is inserted through a pair of washers 41 in abutment with the respective ends of the ~~bush-bushing~~ 40 and a central bore 40a formed in the ~~bush-bushing~~ 40, and threaded into the engine block 8 and tightened to fix the ~~bush-bushing~~ 40 to the engine block 8 and thus to couple the hydraulic auto-tensioner 20 to the engine block 8.

[0033]

The coupling piece 37 of the spring washer 27 mounted on the top end of the rod 23 is formed with a ~~bush-inserting-bushing insertion~~ through hole 43 extending between both sides thereof. A tubular slide bearing 44 is pressed in the hole 43. A tubular ~~bush-bushing~~ 45 is inserted in the slide bearing 44. A bolt 47 is inserted through the ~~bush-bushing~~ 45 and a pair of washers 46 in abutment with the respective ends of the ~~bush-bushing~~ 45, and threaded into a threaded hole 48 formed in the pulley arm 2 and tightened to sandwich the ~~bush-bushing~~ 45 between the head 47a of the bolt 47 and the pulley arm 2, thereby coupling the auto-tensioner 20 to the pulley arm 2.

[0034]

The coupling piece 37 has annular protrusions 49 formed at the respective open ends of the ~~bush-inserting-bushing insertion~~ hole 43 to extend toward the respective washers 46 and to define recesses R radially outside the annular protrusions 49. The washers 46 are each formed with a disk portion 46b, and an outer cylindrical portion 46a covering the corresponding annular protrusion 49, thereby defining a labyrinth 50 ~~between the cylindrical portion 46a and the annular protrusion 49~~ including gap G4 (between the disk portion 46b and an axial end surface of the annular protrusion 49), gap G5 (between the cylindrical portion 46a and

a radially outer surface of the annular protrusion 49), and gap G6 (between an axially-facing bottom of recess R and an axially-facing end surface at the distal end of the cylindrical portion 46a).

[0035]

By providing each of the washers 46 with the outer cylindrical portion 46a, which covers the annular protrusion 49, thus defining the labyrinth 50 therebetween, it is possible to prevent entry of muddy water and dust into between the contact surfaces of the slide bearing 44 and the ~~bush-bushing~~ 45.

[0036]

Since the labyrinth 50 is a non-contact seal, even when the pulley arm 2 and the coupling piece 37 pivot relative to each other, it maintains its sealing function and prevents entry of muddy water and dust for a long period of time.

[0037]

The seal structure, which consists of the annular protrusions 49 of the coupling piece 37 and the outer cylindrical portions 46a of the washers 46, is extremely simple and thus can be manufactured at a low cost.

[0038]

The coupling piece 36 at the bottom end of the cylinder 21 may be coupled to the engine block 8 using the coupling structure through which the pulley arm 2 is coupled to the coupling piece 37 at the top end of the rod 23.

ABSTRACT

~~A In a tension adjusting device for an engine accessory driving belt is provided which can maintain high scalability in the bearing portion about which a pulley arm supporting a tension pulley pivots for a long period of time.~~

~~By~~ by tightening a bolt 7 threaded into an engine block 8, a fulcrum shaft 6 is fixed. A tension pulley 1 is rotatably supported by a pulley arm 2 pivotally supported about the fulcrum shaft 6. A regulating force of a hydraulic auto-tensioner is applied to the pulley arm 2 to press the tension pulley against the belt B. A washer 10 is disposed between a boss 3 formed on the pulley arm 2 and the head 7a of the bolt 7. The washer 10 has an outer cylindrical portion 11 covering one end of the boss 3. A slinger 12 is mounted on the end of the boss 3 to define a labyrinth 13 between the slinger 12 and the cylindrical portion 11, thereby preventing entry of muddy water and dust into the bearing portion pivotally supporting the pulley arm 2.